Aquaculture Quick Facts

AQUACULTURE TODAY

- Aquaculture is the cultivation of animals and plants in water, which could include oceans, rivers, lakes and other water environments. Mariculture is ocean-based or marine aquaculture.

- Global production from aquaculture is increasing by about 11 percent per year and is, "The world's fastest growing food producing sector," according to the United Nations' Food and Agriculture Organization (FAO, 2003).

- Fish and shellfish produced from aquaculture account for 39.5 percent of all seafood consumed by humans (FAO, 2004).

- Fish from aquaculture are very similar in quality to fish from capture fisheries. They are safe to eat, highly nutritious and are sold in most grocery stores.

- Widely available aquacultured fish include Atlantic salmon, tilapia, catfish and rainbow trout, as well as oysters, clams and mussels.

- Aquaculture is also used for replenishment programs for species including salmon, flounder, abalone and white seabass.

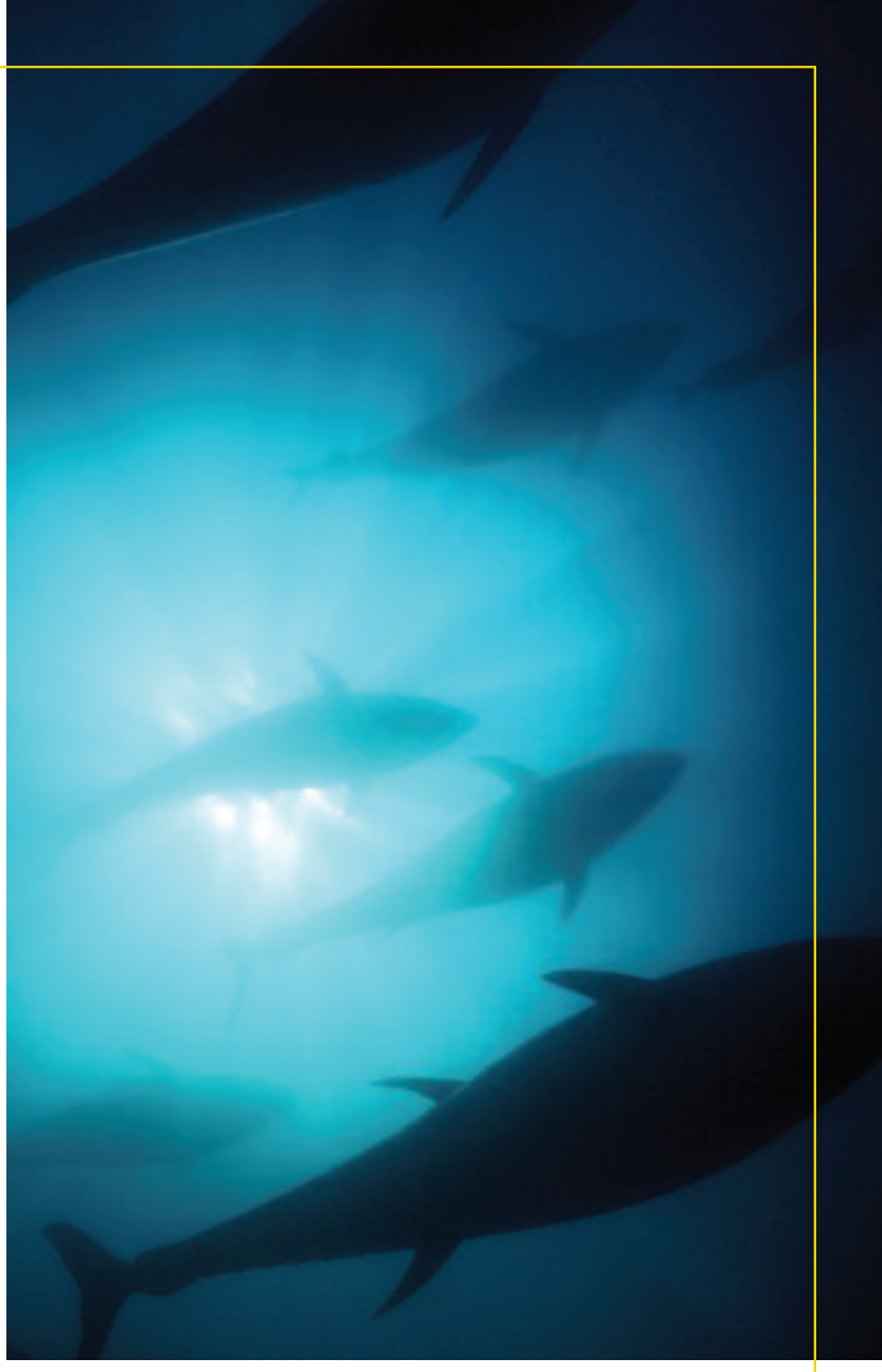
GLOBAL FACTS

- Seafood is our most important single source of high-quality protein, currently providing 16 percent of all animal protein in the human diet.

- Fish is the only important food source that is still primarily gathered from the wild rather than farmed.

- Globally, there are 210 farmed aquatic animal and plant species: 131 finfish, 42 mollusk, 27 crustacean, eight plant, and two amphibian and reptile species (FAO, 2003).

- Domestically, there are 19 commercially cultured species: six finfish, four mollusk, two crustacean, and seven other aquatic plant, amphibian and reptile species (FAO, 2003).



- From 1992 to 2001, total seafood supply increased by 29.4 percent, while supply from wild capture fisheries increased by only 8.3 percent (FAO, 2003). The remainder came from aquaculture.

- Worldwide, more than 38 million people are employed in the interrelated fishing and aquaculture industries (FAO, 2004).

Humanity is dependent on our oceans. HSWRI's research will focus on maintaining or even improving the health of the ocean environment as species such as bluefin tuna (above) are cultured in a deep-water environment.

Fishing is the last food production method to evolve from hunting and gathering to cultivating (from hatching larvae, right) and harvesting (white seabass, below). But the transition is likely inevitable, making good scientific data imperative.

AQUACULTURE IN CALIFORNIA

- California's aquaculture industry is among the most diverse in the nation, varying from small, family-run operations to large, sophisticated, research-and-production facilities.

- California's aquaculture facilities are all in coastal waters, on land or in fresh water. None are currently located in offshore waters.

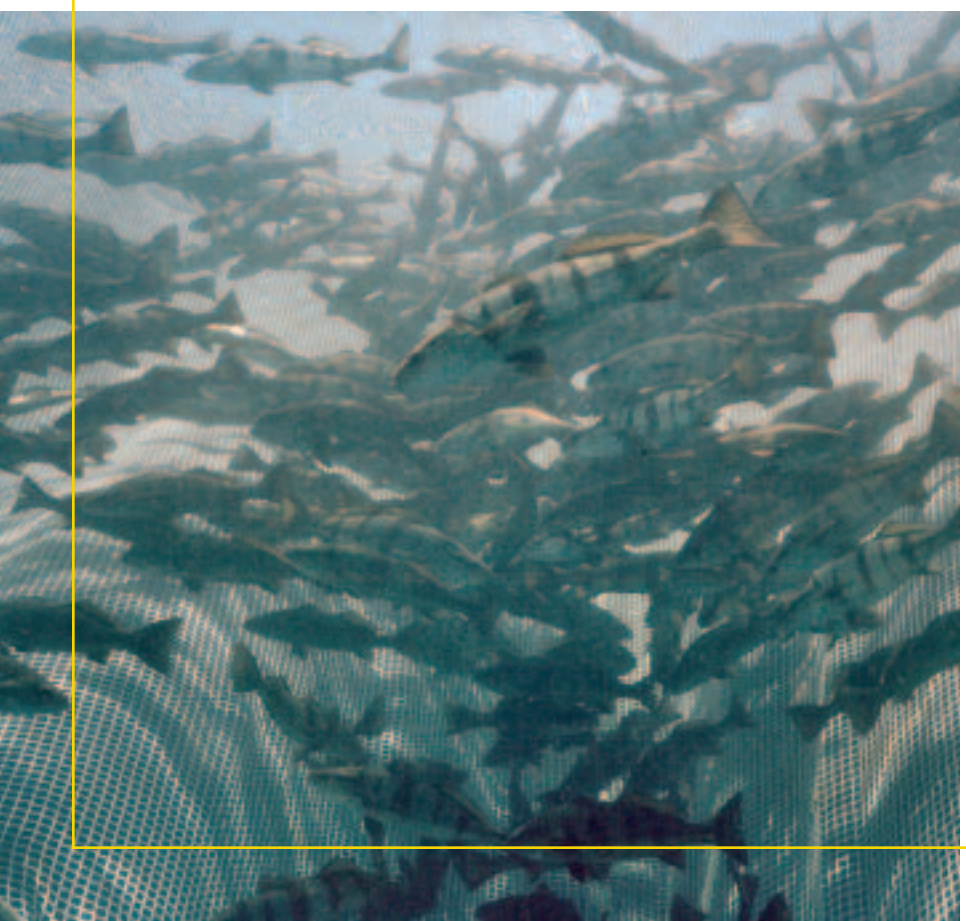
- Catfish, striped bass, tilapia, trout, white sturgeon and algae are among the most common species produced in California. No marine finfish are commercially produced.

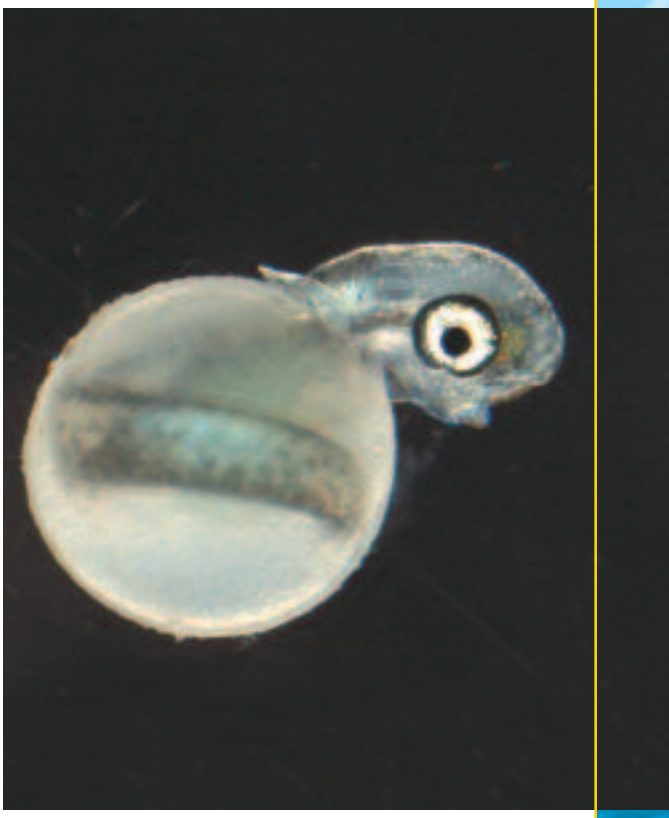
- California has more than 200,000 square miles of ocean with the potential for future mariculture operations.

AQUACULTURE AND THE ENVIRONMENT

- The aquaculture industry will not be able to succeed unless it uses ecologically sound practices and manages resources sustainably.

- Properly managed aquaculture can generate significant economic and social benefits with little or no environmental impact. In fact, some impacts, such as increased reef habitat, can be highly beneficial.





- Responsible aquaculture development will require regulatory agencies, universities, fishermen and scientists to work in concert to ensure that all environmental, logistical, legal and sociopolitical considerations are addressed.

THE NEED FOR INCREASED PRODUCTION

- Annual domestic demand for seafood is projected to increase by 3.3 billion pounds (35 to 50 percent) by the year 2010 (FAO, 2003).

- This demand can only be met by complementing sustainable harvests from fisheries with increased production from aquaculture.

- Most supplies are likely to be imported because prospects for increasing supply from our fisheries are few and our aquaculture industry is still relatively undeveloped.

- The U.S. is the third largest consumer of seafood in the world, but only 11th in volume of aquaculture producers (FAO, 2003).

- Recognizing this, the Department of Commerce is seeking ways to expand domestic aquaculture consistent with its goals for sustainable development.

Aquaculture Issues

ISSUE 1: FEEDING FISH TO FISH TO MAKE MORE FISH

Background: Most ocean fish consumed in the U.S. are carnivorous—that is, they consume other marine animals (fish, squid, crustaceans, etc). Aquaculture feeds usually rely on fishmeal as the primary protein source. Fishmeal is produced from baitfish such as sardines, anchovies, herring and menhaden and, in some cases, fish processing by-products.

A concern about mariculture is increasing amounts of baitfish will be caught for use in feeds. The result, some argue, is that we will be reducing the net amount of protein by farming.

Factoids:

- All animals use energy from food for more than just body growth, hence they need more food than is stored in their bodies.

- Wild fish are less efficient at converting protein (baitfish in the wild) into protein (body mass) than farmed fish (baitfish used in feed). Experts in fish nutrition report that using fish meal to produce high-value fish for human consumption in aquaculture can be 5.5 times more efficient than this transformation in nature.

- Cultured fish are more efficient than land-based livestock at converting their feed into body mass.

- Researchers and feed companies have made substantial progress in substituting other ingredients (e.g., vegetable proteins and vegetable oil) for fishmeal and fish oil in aquaculture feeds, a trend that will continue for simple economic reasons—the alternatives are cheaper.

- Global production of fishmeal has remained stable for the last 15 years while global aquaculture production has increased almost threefold. This is the result of increasing efficiencies and changing composition of aquaculture feeds.

- The fish that are used for fishmeal are unpalatable. They are small, bony and extremely fishy tasting. Attempts to incorporate them into human diets have failed.

- Worldwide, the majority of fishmeal (approximately 65 percent) is used in livestock feeds for the pig and poultry industries, as well as for fertilizer.

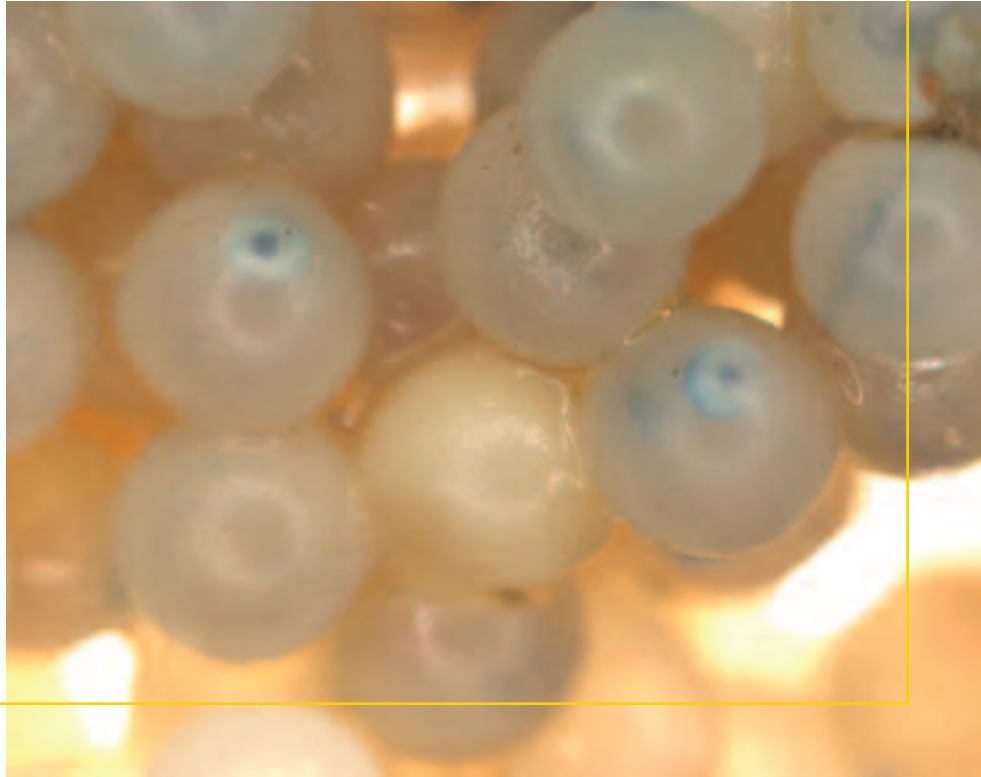
- Scientists and fishery managers generally believe that fishmeal fisheries are some of the best managed and sustainable fisheries.

- Eight percent of the world's capture fishery output is discarded as bycatch, while there are no discards from aquaculture.

ISSUE 2: NUTRIENTS FROM AQUACULTURE WASTES AND THE MARINE ENVIRONMENT

Background: Like all other animals, as fish metabolize food, they produce wastes—soluble nitrogenous compounds and feces. A concern is that excess wastes from aquaculture can cause localized problems such as build-up of sediment on the seabed or organic changes in the water column that may have unwanted effects. Mariculture operations must therefore be located and managed to provide for the adequate dispersal and natural assimilation of wastes.

Usually this means areas with medium to strong tidal currents and water depth greater than 60 feet. A criticism of such an approach is that dilution is not the solution to pollution. But these are beneficial wastes—nutrients. On land,



HSWRI will begin with eggs (below) that have been taken from wild caught fish, and then hatch and raise them to harvest size.

The Grace Mariculture Project is designed to assess and address issues associated with the commercial culture of species such as bluefin tuna (above), as well as other finfish and commercially popular shellfish.

animal wastes are routinely used as fertilizer. In fact, under appropriately controlled conditions, this is a prerequisite of organic farming.

It is entirely possible that, if all the interacting factors can be understood, mariculture wastes can result in a beneficial, localized enhancement of marine flora and fauna, including natural fisheries. One of the goals for the Grace Mariculture Project is to develop means to predict and even control localized increases in productivity. HSWRI sees an opportunity to turn the impact of wastes into a benefit and believes that this should be a priority area for its mariculture research effort.

Factoids:

- The wastes from mariculture projects are the same as those from wild fish. In addition, there is often a small proportion of uneaten feed that passes through the net meshes and into the water column. These wastes do not contain toxic substances, unlike many industrial and even domestic wastes, and they are biodegradable.

- Ammonia and urea are quickly oxidized by marine bacteria and become nitrate, which is a basic plant nutrient.

- Solid wastes are also biodegraded by bacteria or in some part consumed by marine invertebrates. But this process is slower and, therefore, these wastes can accumulate on the seabed.

- Uneaten feed is, in well-managed farms, a very minor proportion of solid waste. Obviously, it is not economical to use expensive raw materials inefficiently. Today, fish farmers use a variety of monitoring devices, such as underwater cameras and acoustic Doppler systems, to ensure that the fish are adequately fed with minimal feed waste.

- Adverse effects on the cultured fish themselves are almost always the first indicators of excessive soluble wastes. It is in a fish farmer's best interests to prevent this. Examples of soluble wastes causing problems in mariculture are extremely rare.

- Accumulation of solid wastes under a mariculture facility can be monitored by regular sediment sampling. In many cases, it actually leads to an increase in sea floor (benthic) productivity and increased aggregations of fish and marine invertebrates, changes that may be considered beneficial. Benthic monitoring will be conducted routinely as part of the Grace Mariculture Project, according to EPA guidelines and the project's environmental sampling program.

- Above all else, the management and potentially beneficial assimilation of wastes is a matter of scale. Relative to the mass of ocean water surrounding Platform Grace, the HSWRI pilot project will be, for all practical purposes, insignificant. However, it will also be a significant first step in understanding the capacity of California's offshore waters to support this vital, new industry.

ISSUE 3: ANTIBIOTICS USED IN FISH FARMS

Background: Antibiotics are used to treat disease in all forms of animal farming. The likelihood that pathogens develop resistance increases over time. Excessive use of antibiotics exacerbates this process and is, therefore, to be discouraged.

Factoids:

- Disease prevention is the best way to minimize the need for antibiotics. Good water quality combined with sound management practices, such as low stocking densities and use of high-quality feed, are effective disease prevention mechanisms.

- Very few antibiotics are approved for use in farming food fish and the use of any is strictly regulated by the Food and Drug Administration (FDA).

- Any use of antibiotics by HSWRI is approved in advance by a licensed veterinarian.

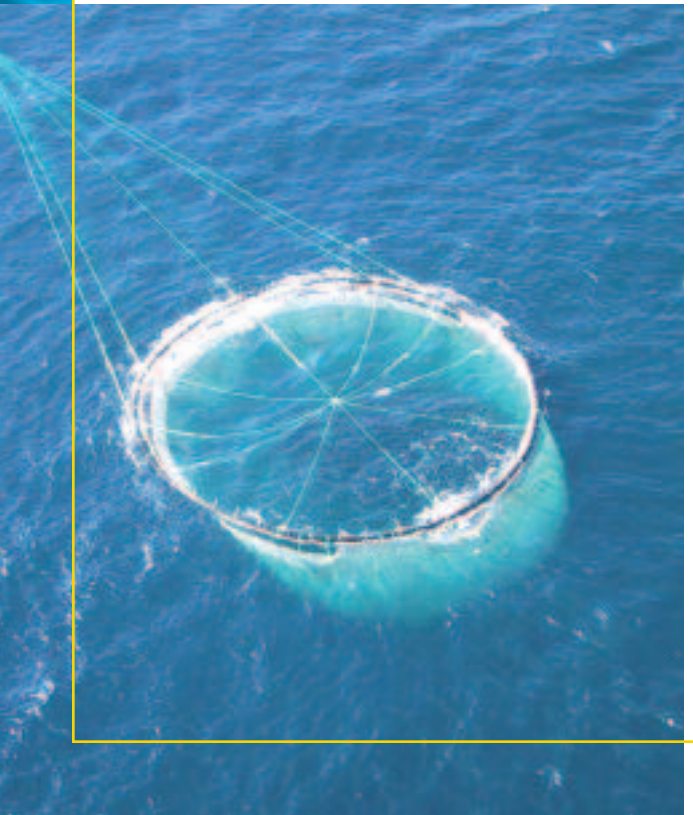
- The use of vaccines is another way to minimize the need for antibiotics. Vaccines have been especially effective in the salmon farming industry and the techniques learned with salmon are now applicable to other mariculture species.

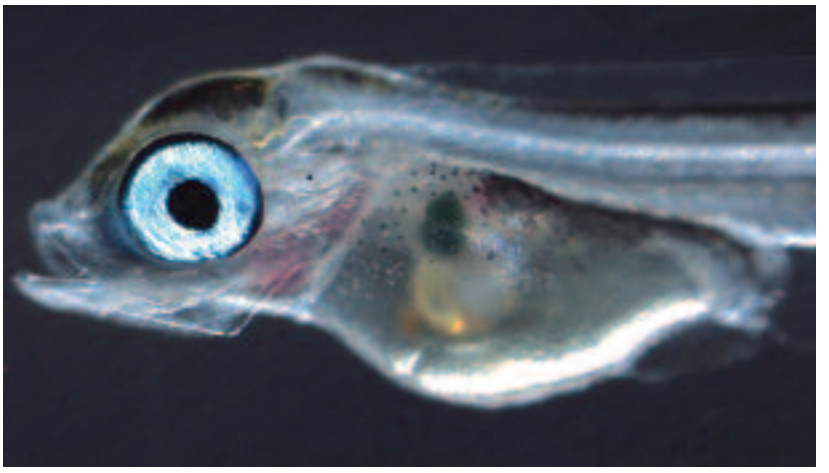
ISSUE 4: ESCAPED FISH INTERACTIONS WITH WILD POPULATIONS

Background: One school of thought is that escaped, farmed fish may impact wild populations if they breed, through competition and possibly by disease transfer.

Factoids:

- HSWRI will only be farming endemic (i.e., native to the area) species as part of the Grace Mariculture Project.





- No genetically modified fish products are commercially available in the U.S. Additionally, California maintains strict regulations regarding the use of genetically modified organisms in aquaculture. HSWRI will not use any genetically modified organisms in the Grace Mariculture Project.

- In collaboration with the California Department of Fish and Game, HSWRI has released cultured fish into the ocean for nearly 20 years. During this period, HSWRI has consulted experts from around the world to understand and minimize the risks of allowing cultured fish to interact with wild ones.

- HSWRI employs the best available cage equipment and strict practices to avoid system failures. HSWRI has operated a net pen facility at Santa Catalina Island for the past seven years without a single incident of system failure or escape.

ISSUE 5: PCBS IN CULTURED FISH

Background: The presence of PCBs (polychlorinated biphenyls) in both wild and farmed salmon is a concern that some translate as a significant issue for all aquaculture operations.

Factoids:

- The most recent research shows that the levels of PCBs in wild and farmed salmon are virtually the same—about 1/200th of the FDA tolerance, and pose no health risk to consumers, according to leading public health organizations worldwide.

- With wild or farmed salmon in particular, the risks from PCBs are outweighed by the benefits of omega-3 fatty acids and other nutritional factors.

From eggs to fry (above) to adult fish grown out in ocean cages (below), HSWRI will study in depth all stages of mariculture to help guide the beneficial development of this new agricultural science.

Scientific research will lead to a better understanding of the potential risks – such as PCBs and mercury – weighed against the proven benefits of eating fish such as white seabass (above) and other seafood.

- It is easier to limit fish intake of PCBs in aquaculture (by controlling PCBs in fish oil and fish meal) than it is to limit such intake in the wild. For that reason, it is likely that that PCB levels in farmed fish may soon be lower than those in wild fish.

- The levels of PCBs in other foods, such as butter, are higher than in salmon.

- Overall levels of PCBs in all foods have declined about 90 percent since they were banned in the late 1970s.

- Interestingly, there is no scientific evidence that PCBs cause cancer in humans, even in workers exposed to high levels for many years, according to Dr. Michael Gallo of the Cancer Institute at the Robert Wood Johnson Medical School.

ISSUE 6: MERCURY IN WILD AND CULTURED FISH

Background: Mercury poisoning has been an issue since the 19th century when it was known as "Mad Hatter's syndrome." Hat manufacturers were exposed to mercury in the felting process and developed neurological problems. It became a seafood issue when a series of mercury poisonings in Minimata, Japan became an international media story.

Factoids:

- Mercury is naturally occurring, although coal-fired energy plants are believed to exacerbate the problem. It precipitates out of the atmosphere in rain, and is therefore found in even remote bodies of water. Through organic processes, elemental mercury is converted into methylmercury, a neurotoxin.

- It is widely believed that mercury (methylmercury) is ingested by small fish, which, in turn, are eaten by larger fish. The higher up the food chain, in general, the greater the concentrations of mercury. Larger, longer-lived, carnivorous fish tend to have relatively high concentrations.

- Although linked with neurological disorders such as memory loss, birth defects, and increased risk of hearts attacks and coronary disease, most regulatory agencies believe it is only an acute issue for pregnant and nursing mothers, and young children. Although the American Medical Association, among others, wants more research, several regulatory agencies have set "safe" limits for mercury levels.

- Mercury levels in fish are down slightly or the same as they have been since the 1970s, according to a 2005 U.S. House of Representatives Resources Committee report. New efforts such as the EPA's Clean Air Mercury Rule are likely to reduce mercury emissions.

- The EPA recommends avoiding species that have high levels of mercury, limiting weekly intake and varying which species are eaten.

- Like all farmed animals, cultured fish are given controlled diets. By testing for mercury in feed, fish farmers can better monitor and minimize mercury intake in their fish.

- In Australia, farmed tuna have been extensively tested for mercury and, as a result, have been removed from the mercury advisory list. Further testing may provide a better sense of the actual risks weighed against the widely acknowledged, proven benefits of eating seafood.